TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 404

TESTS OF N.A.C.A. AIRFOILS IN THE VARIABLE-DENSITY WIND TUNNEL

SERIES 24

By Eastman N. Jacobs and Kenneth E. Ward
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SUMMARY

This note is the fifth of a series covering an investigation of a number of related airfoils. It presents the results obtained from tests of a group of six low-cambered airfoils in the variable-density wind tunnel. The mean camber lines are identical for the six airfoils and are of such a form that the maximum mean camber is 2 per cent of the chord and is at a position 0.4 of the chord behind the leading edge. The airfoils differ in thickness only, the maximum-thickness/chord ratios being 0.06, 0.09, 0.12, 0.15, 0.18, and 0.21. The results have been presented in the form of both infinite and finite aspect-ratio characteristics. The values of $\frac{C_{L\ max}}{C_{D_{o}\ min}}$ for this group of airfoils are among the highest thus far obtained, the minimum profile drags being approximately equal to those for the symmetrical series of corresponding thickness, while the maximum lift coefficients are considerably higher.

INTRODUCTION

A large number of related airfoils are being tested in the variable-density wind tunnel of the National Advisory Committee for Aeronautics with a view to establishing the relation between the geometric and the aerodynamic characteristics of airfoils at a high value of the Reynolds Number. The method employed to develop the airfoils having varying geometric properties is described in detail in references 1 and 2. Briefly, the profiles are obtained by combining certain thickness forms (reference

1) with several related mean camber line forms (reference 2). The airfoils are designated by a number of four digits: the first indicates the maximum mean camber, the second the position of maximum mean camber, and the last two the maximum thickness.

Preliminary results already published include those for the six symmetrical N.A.C.A. airfoils, the 00 series (reference 1); and those for 36 cambered airfoils, the 43 and 63 series (reference 2), the 45 and 65 series (reference 3), and the 44 and 64 series (reference 4).

The results thus far obtained, some of which have not been published, indicate that low-cambered airfoils are generally the most efficient. The values of $\frac{C_{L\,max}}{C_{D_{o}\,min}}$ for the low-cambered airfoils reported herein (24 series) are among the highest thus far obtained and the minimum profile-drag coefficients are approximately equal to those for the symmetrical series of corresponding thickness.

The data for the 24-series airfoils are therefore presented in this report in a more complete form than that previously used. For the convenience of the designer and also to facilitate comparisons between these and other airfoil data, the results are presented in the standard graphical form.

DESCRIPTION OF AIRFOILS

The 24-series airfoils were derived by combining six related profile thickness forms (reference 1) with one form of mean camber line. The combination was made by the method described in reference 2. The form of the 24-series mean camber line is given by the following equations:

From $x = 0$ to $x = 0.4$ From $x = 0.4$ to $x = 1$

$$y_c = \frac{2}{160}(8x - 10x^2) \qquad y_c = \frac{2}{180}(1 + 4x - 5x^2)$$

The resulting ordinates for the airfoils are given in Tables I to VI, and the profiles are shown in Figure 1.

In addition to those tables of basic ordinates, the familiar form of ordinates, which were obtained at the standard stations, are tabulated in Figures 5 to 10, together with outline drawings of the profiles. From the basic ordinates, 5 by 30 inch duralumin airfoils were made as described in reference 1, and were used for the tests.

TESTS AND RESULTS

Routine tests of the six airfoils were made in the variable-density wind tunnel at a Reynolds Number of approximately 3,000,000. Measurements were taken of the lift, drag, and pitching moment about the quarter-chord. A description of the tunnel and of the method of testing is given in reference 1.

The results have been given as coefficients corrected, after the method of reference 5, to give airfoil characteristics for infinite aspect ratio and aspect ratio 6. Tables VII to XII present: lift coefficient C_L, angle of attack for infinite aspect ratio α_0, profile-drag coefficient C_{D_0}, and pitching-moment coefficient about a point one-quarter of the chord behind the leading edge $C_{m_{c/4}}$. These data are plotted in Figures 2, 3, and 4. The characteristics for aspect ratio 6 are given in Figures 5 to 10 in which are plotted the lift coefficient C_L, drag coefficient C_D, L/D ratio, and center-of-pressure position for each airfoil.

DISCUSSION

The airfoil characteristics are discussed with respect to their variation with thickness and also with respect to lift or angle of attack. This discussion is given briefly as it follows the general procedure of references 1 to 4. In addition to this discussion, the relative merits of these airfoils are shown by means of a table of the characteristics usually employed for this purpose.

<u>Variation of the aerodynamic characteristics with thickness</u>.- The variation of the minimum profile-drag coefficient with maximum thickness is shown in Figure 11. In this figure are plotted the values taken from the

faired profile-drag curves (fig. 2) and the curve expressed by the equation

$$C_{D_{o\ min}} = 0.0065 + 0.0083t + 0.0972t^2 + k$$

relating the minimum profile-drag coefficient (C_{D_o}) and the maximum-thickness/chord ratio (t). (Reference 2.) This equation, without the term k, was developed in reference 1 to express the minimum drag of the symmetrical series airfoils. For the 24-series airfoils the value of the constant k, which depends on the camber, becomes negligible.

As with the previously tested airfoils, the sections of moderate thickness give the highest maximum lift coefficients. A table of these coefficients taken from Figure 3 is given below:

Airfoil	$C_{L\ max}$
2406	1.01
2409	1.51
2412	1.59
2415	1.55
2418	1.43
2421	1.35

The variation of the slope of the lift curve with thickness is shown in Figure 12. The points on the figure represent the slopes as measured in the angle-of-attack range near minimum profile drag for an infinite-span wing.

The pitching-moment coefficients at zero lift are given in the following table:

Airfoil	C_{m_o}
2406	-0.039
2409	- .044
2412	- .042
2415	- .040
2418	- .038
2421	- .036

The variation of the ratio $\dfrac{C_{L\ max}}{C_{D_{o\ min}}}$ with maximum

thickness is shown in Figure 13. It is interesting to note that the N.A.C.A. 2409 gives a value of 189 for this ratio, the highest value that has been obtained for any airfoil thus far tested in this tunnel.

<u>Variation of the aerodynamic characteristics with lift or angle of attack</u>.- The variation of the profile-drag coefficient with lift coefficient is shown in Figure 2, and the variation of the additional profile-drag coefficient $(C_{D_o} - C_{D_o\,min})$ with lift is shown in Figure 14. In the latter figure is plotted the curve given by the previously used equation (reference 2),

$$C_{D_o} = C_{D_o\,min} + 0.0062\,(C_L - C_{L\,opt})^2$$

where $C_{L\,opt}$ is the optimum-lift coefficient defined as the value of the lift coefficient corresponding to minimum profile drag. Reference to the figure shows that this expression holds very well for the present series.

The optimum lift coefficients for the 24-series airfoils are given in the following tables

Airfoil	$C_{L\,opt}$
2406	0.23
2409	.19
2412	.16
2415	.12
2418	.09
2421	.05

The variation of the pitching-moment coefficient with angle of attack is shown in Figure 4. As discussed in the preceding publications, the moment is not constant about the quarter-chord point but tends to be constant about a point displaced forward from it as indicated in the following table:

Airfoil	Displacement (per cent of chord)
2406	0.6
2409	.6
2412	.7
2415	.8
2418	1.1
2421	1.4

Comparison of the airfoils.- The airfoil characteristics may be most conveniently compared by means of the following table, compiled from the data in the preceding tables and in the curves, giving the characteristics usually employed for this purpose:

Airfoil	C_L max	C_{D_0} min	$\frac{C_L \text{ max}}{C_{D_0} \text{ min}}$	C_{m_0} moment coeff. at zero lift	A.R. 6 C_D minimum	A.R. 6 L/D maximum	Thickness at 0.15 chord	Thickness at 0.65 chord	c.p. at C_L max	c.p. at 1/4 C_L max
							Per cent chord		Per cent chord	
2406	1.01	0.0070	145	-0.039	0.0072	25.0	5.3	4.1	36	40
2409	1.51	.0080	189	- .044	.0081	23.2	8.0	6.2	28	36
2412	1.59	.0090	177	- .042	.0091	21.9	10.7	8.3	28	35
2415	1.55	.0099	156	- .040	.0099	20.8	13.4	10.3	28	35
2418	1.43	.0112	128	- .038	.0112	19.4	16.1	12.4	28	34
2421	1.35	.0127	106	- .036	.0127	17.9	18.8	14.5	29	34

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., December 19, 1931.

REFERENCES

1. Jacobs, Eastman N.: Tests of Six Symmetrical Airfoils in the Variable-Density Wind Tunnel. T.N. No. 385, N.A.C.A., 1931.

2. Jacobs, Eastman N., and Pinkerton, Robert M.: Tests of N.A.C.A. Airfoils in the Variable-Density Wind Tunnel. Series 43 and 63. T.N. No. 391, N.A.C.A., 1931.

3. Jacobs, Eastman N., and Pinkerton, Robert M.: Tests of N.A.C.A. Airfoils in the Variable-Density Wind Tunnel. Series 45 and 65. T.N. No. 392, N.A.C.A., 1931.

4. Jacobs, Eastman N., and Pinkerton, Robert M.: Tests of N.A.C.A. Airfoils in the Variable-Density Wind Tunnel. Series 44 and 64. T.N. No. 401, N.A.C.A., 1931.

5. Jacobs, Eastman N., and Anderson, Raymond F.: Large-Scale Aerodynamic Characteristics of Airfoils as Tested in the Variable-Density Wind Tunnel. T.R. No. 352, N.A.C.A., 1930.

TABLE I

Ordinates for Airfoil N.A.C.A. 2406
(Dimensions in per cent of chord)

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
-	-	0	0
1.159	1.066	1.341	-0.820
2.378	1.543	2.622	-1.059
4.845	2.240	5.155	-1.302
7.330	2.772	7.670	-1.414
9.825	3.210	10.175	-1.460
14.833	3.887	15.167	-1.449
19.857	4.365	20.143	-1.365
29.925	4.875	30.075	-1.125
40.000	4.901	40.000	- .901
50.029	4.592	49.971	- .704
60.051	4.059	59.949	- .503
70.061	3.331	69.939	- .331
80.058	2.421	79.942	- .199
90.040	1.334	89.960	- .112
95.025	.724	94.975	- .086
100.004	.063	99.996	- .063
L.E. radius	.394		
Slope of radius passing through end of chord	2/20		

TABLE II

Ordinates for Airfoil N.A.C.A. 2409
(Dimensions in per cent of chord)

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
-	-	0	0
1.113	1.537	1.387	-1.291
2.317	2.193	2.683	-1.709
4.768	3.127	5.232	-2.189
7.245	3.819	7.755	-2.461
9.737	4.379	10.263	-2.629
14.750	5.222	15.250	-2.784
19.785	5.800	20.215	-2.800
29.887	6.376	30.113	-2.626
40.000	6.351	40.000	-2.351
50.044	5.915	49.956	-2.027
60.076	5.200	59.924	-1.644
70.092	4.246	69.908	-1.246
80.087	3.075	79.913	- .853
90.060	1.696	89.940	- .474
95.037	.923	94.963	- .285
100.006	.095	99.994	- .095
L.E. radius	.887		
Slope of radius passing through end of chord	2/20		

TABLE III

Ordinates for Airfoil N.A.C.A. 2412
(Dimensions in per cent of chord)

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
-	-	0	0
1.067	2.009	1.433	-1.763
2.256	2.845	2.744	-2.361
4.690	4.013	5.310	-3.075
7.160	4.865	7.840	-3.507
9.650	5.545	10.350	-3.795
14.667	6.554	15.333	-4.116
19.713	7.231	20.287	-4.231
29.850	7.875	30.150	-4.125
40.000	7.803	40.000	-3.803
50.059	7.238	49.941	-3.350
60.101	6.340	59.899	-2.784
70.122	5.163	69.878	-2.163
80.116	3.729	79.884	-1.507
90.080	2.058	89.920	-.836
95.049	1.124	94.951	-.486
100.008	.126	99.992	-.126
L.E. radius	1.576		
Slope of radius passing through end of chord	2/20		

TABLE IV

Ordinates for Airfoil N.A.C.A. 2415
(Dimensions in per cent of chord)

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
-	-	0	0
1.022	2.480	1.478	-2.234
2.195	3.496	2.805	-3.012
4.612	4.898	5.388	-3.960
7.075	5.912	7.925	-4.554
9.562	6.715	10.438	-4.965
14.583	7.889	15.417	-5.451
19.642	8.663	20.358	-5.663
29.813	9.376	30.187	-5.626
40.000	9.254	40.000	-5.254
50.074	8.563	49.926	-4.675
60.127	7.481	59.873	-3.925
70.153	6.077	69.847	-3.077
80.145	4.385	79.855	-2.163
90.100	2.419	89.900	-1.197
95.062	1.328	94.938	- .690
100.011	.158	99.989	- .158
L.E. radius	2.464		
Slope of radius passing through end of chord	2/20		

TABLE V

Ordinates for Airfoil N.A.C.A. 2418
(Dimensions in per cent of chord)

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
-	-	0	0
.976	2.952	1.524	-2.706
2.134	4.145	2.866	-3.661
4.535	5.784	5.465	-4.846
6.990	6.958	8.010	-5.600
9.475	7.879	10.525	-6.129
14.500	9.224	15.500	-6.786
19.570	10.095	20.430	-7.095
29.775	10.875	30.225	-7.125
40.000	10.702	40.000	-6.702
50.088	9.886	49.912	-5.998
60.152	8.622	59.848	-5.066
70.183	6.992	69.817	-3.992
80.175	5.042	79.825	-2.820
90.121	2.781	89.879	-1.559
95.074	1.526	94.926	- .888
100.013	.189	99.987	- .189
L.E. radius	3.549		
Slope of radius passing through end of chord	2/20		

TABLE VI

Ordinates for Airfoil N.A.C.A. 2421
(Dimensions in per cent of chord)

Upper surface		Lower surface	
Station	Ordinate	Station	Ordinate
-	-	0	0
.930	3.424	1.570	-3.178
2.073	4.796	2.927	-4.312
4.458	6.665	5.542	-5.727
6.905	8.005	8.095	-6.647
9.387	9.046	10.613	-7.296
14.416	10.555	15.584	-8.117
19.499	11.526	20.501	-8.526
29.738	12.375	30.262	-8.625
40.000	12.155	40.000	-8.155
50.103	11.208	49.897	-7.320
60.178	9.761	59.822	-6.205
70.214	7.906	69.786	-4.906
80.204	5.697	79.796	-3.475
90.141	3.143	89.859	-1.921
95.086	1.726	94.914	-1.088
100.015	.221	99.985	- .221
L.E. radius	4.830		
Slope of radius passing through end of chord	2/20		

TABLE VII

AIRFOIL: N.A.C.A. 2406

Average Reynolds Number: 3,120,000

Size of model: 5 by 30 inches

Pressure, standard atmospheres: 20.7

Test No.: 665 Variable-Density Tunnel. Sept. 8, 1931.

C_L	α_o (degrees)	C_{D_o}	$C'_{m_{c/4}}$
-0.483	-6.5	0.0197	-0.038
- .182	-3.4	.0084	- .040
- .026	-1.9	.0075	- .039
.131	- .4	.0071	- .039
.287	1.1	.0069	- .038
.437	2.6	.0077	- .037
.747	5.6	.0101	- .039
.936	9.0	.0676	- .039
1.012	12.8	.1903	- .098
.993	16.8	.2920	- .145
.927	21.1	.3686	- .162
.902	27.1	.4838	- .175

TABLE VIII

AIRFOIL: N.A.C.A. 2409

Average Reynolds Number: 3,110,000

Size of model: 5 by 30 inches

Pressure, standard atmospheres: 20.8

Test No.: 666 Variable-Density Tunnel. Sept. 9, 1931

C_L	α_o (degrees)	C_{D_o}	$C'_{m_{c/4}}$
-0.172	-3.5	0.0087	-0.045
- .018	-1.9	.0082	- .044
.138	- .4	.0080	- .043
.291	1.1	.0081	- .042
.449	2.6	.0087	- .041
.750	5.6	.0103	- .042
1.054	8.6	.0139	- .042
1.339	11.7	.0204	- .045
1.461	13.4	.0269	- .046
1.513	14.2	.0316	- .048
1.414	15.5	.0912	- .085
1.145	20.4	.3192	- .144
.933	27.0	.4776	- .167

TABLE IX

AIRFOIL: N.A.C.A. 2412

Average Reynolds Number: 3,020,000

Size of model: 5 by 30 inches

Pressure, standard atmospheres: 20.6

Test No.: 667 Variable-Density Tunnel. Sept. 9, 1931

C_L	α_o (degrees)	C_{D_o}	$C'_{m_{c/4}}$
-0.178	-3.4	0.0096	-0.043
- .026	-1.9	.0092	- .042
.133	- .4	.0090	- .041
.288	1.1	.0091	- .040
.439	2.6	.0095	- .039
.744	5.6	.0110	- .039
1.049	8.7	.0143	- .039
1.328	11.8	.0201	- .041
1.457	13.4	.0261	- .043
1.566	15.0	.0352	- .043
1.589	15.8	.0422	- .045
1.307	19.8	.2269	- .113
1.003	26.8	.4189	- .161

TABLE X

AIRFOIL: N.A.C.A. 2415

Average Reynolds Number: 3,060,000

Size of model: 5 by 30 inches

Pressure, standard atmospheres: 20.8

Test No.: 668 Variable-Density Tunnel. Sept. 10, 1931.

C_L	α_o (degrees)	C_{D_o}	$C_{m_{c/4}}'$
-0.169	-3.5	0.0104	-0.042
- .016	-1.9	.0100	- .040
.136	- .4	.0099	- .039
.287	1.1	.0099	- .037
.436	2.6	.0106	- .036
.741	5.6	.0120	- .034
1.030	8.7	.0153	- .034
1.310	11.8	.0216	- .036
1.431	13.5	.0270	- .036
1.529	15.1	.0377	- .039
1.545	16.4	.0631	- .051
1.485	17.3	.1066	- .065
1.393	19.6	.1858	- .091
1.064	26.6	.3818	- .140

TABLE XI

AIRFOIL: N.A.C.A. 2418

Average Reynolds Number: 3,060,000

Size of model: 5 by 30 inches

Pressure, standard atmospheres: 20.8

Test No.: 669 Variable-Density Tunnel. Sept. 11, 1931

C_L	α_o (degrees)	C_{D_o}	$C_{m_{c/4}}'$
-0.158	-3.5	0.0117	-0.039
- .011	-2.0	.0113	- .038
.142	- .5	.0112	- .036
.293	1.1	.0115	- .034
.438	2.6	.0118	- .032
.736	5.7	.0136	- .030
1.020	8.8	.0173	- .027
1.278	11.9	.0259	- .028
1.433	15.4	.0639	- .041
1.391	17.6	.1295	- .063
1.354	19.7	.1855	- .080
1.102	26.5	.3610	- .125

TABLE XII

AIRFOIL: N.A.C.A 2421

Average Reynolds Number: 3,000,000

Size of model: 5 by 30 inches

Pressure, standard atmospheres: 20.6

Test No.: 670 Variable-Density Tunnel. Sept. 11, 1931

C_L	α_o (degrees)	C_{D_o}	$C_{m_{c/4}}'$
-0.171	-3.5	0.0133	-0.039
- .022	-1.9	.0128	- .036
.125	- .4	.0127	- .033
.271	1.1	.0131	- .031
.418	2.7	.0136	- .029
.698	5.8	.0160	- .025
.975	8.9	.0201	- .023
1.222	12.1	.0294	- .024
1.347	15.7	.0813	- .043
1.340	17.7	.1284	- .057
1.321	19.8	.1781	- .072
1.116	26.5	.3348	- .112

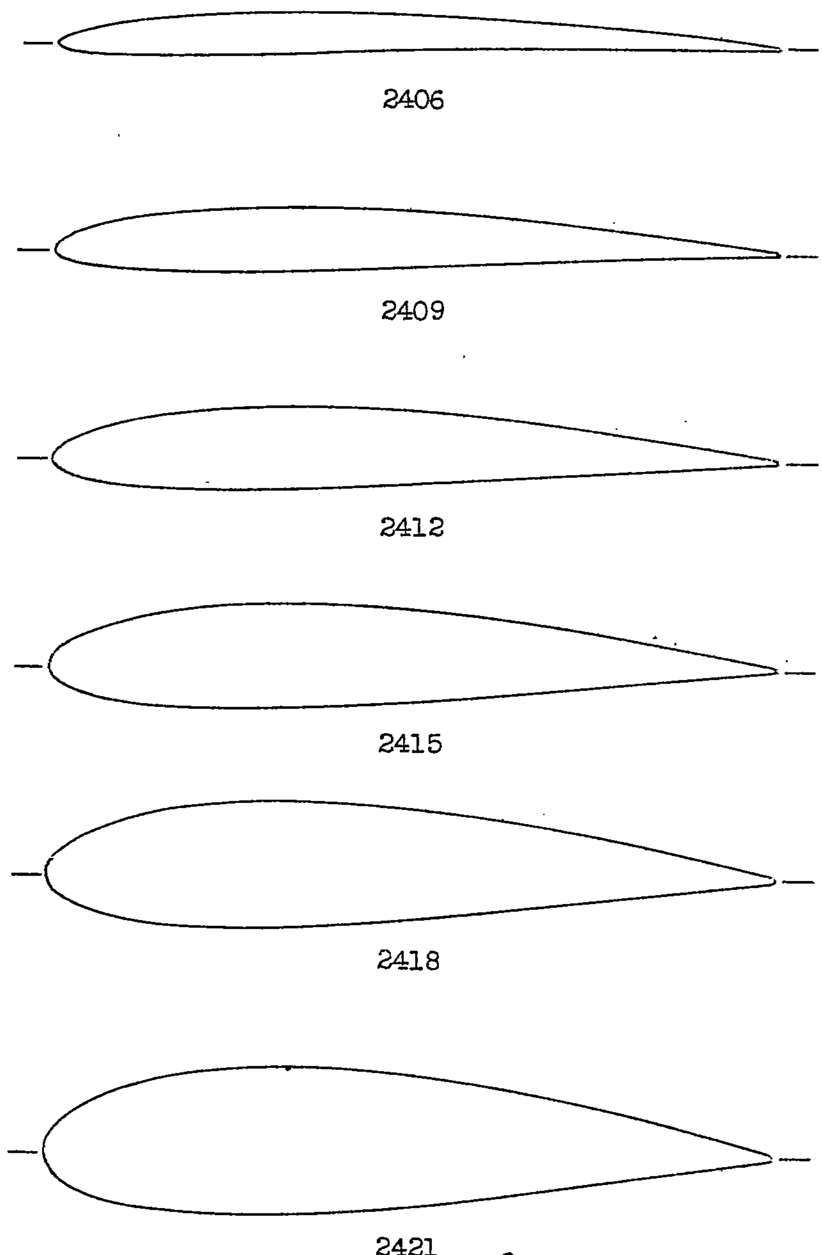


Fig. 1 N.A.C.A. airfoil profils. Series 24

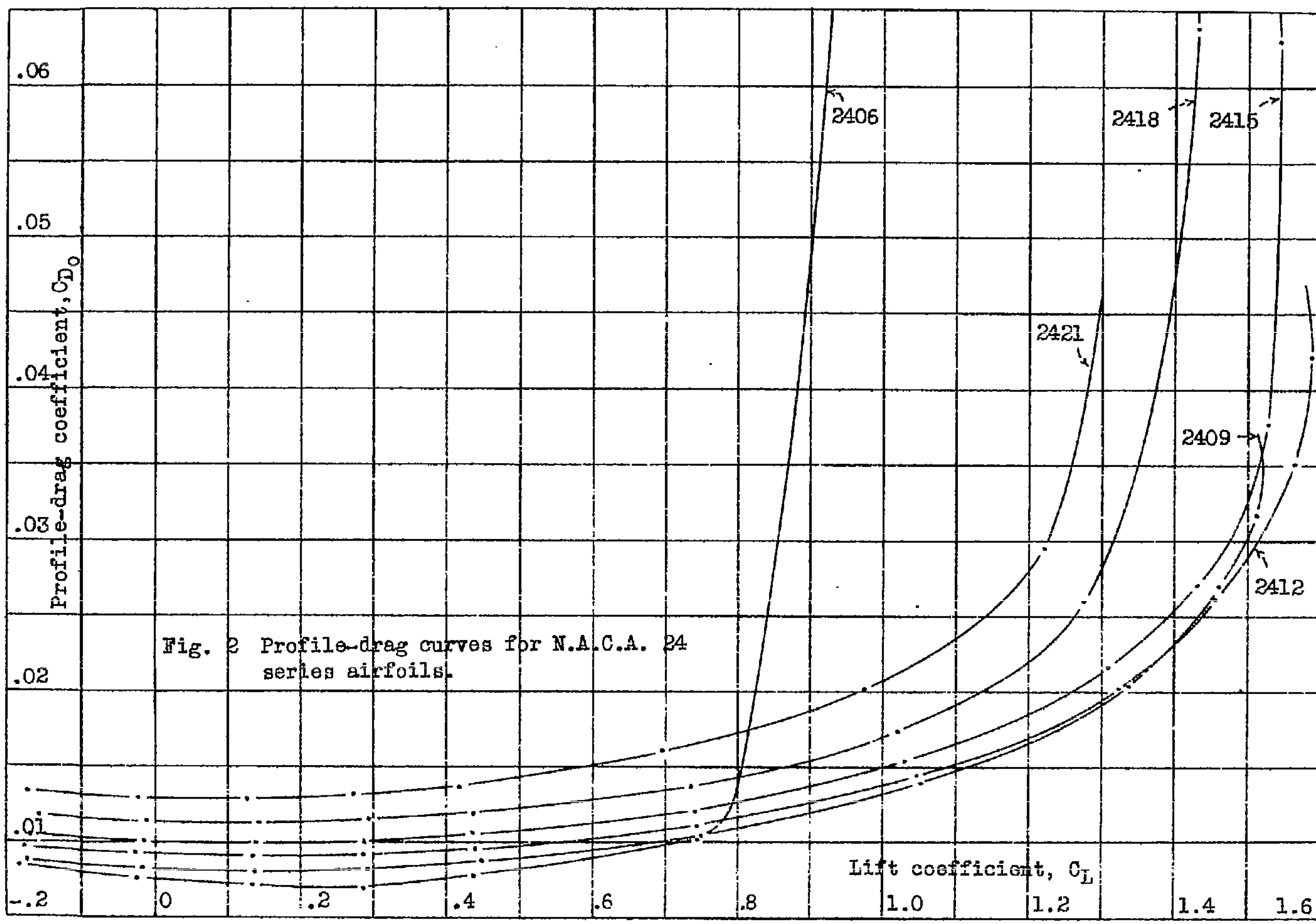


Fig. 2 Profile-drag curves for N.A.C.A. 24 series airfoils.

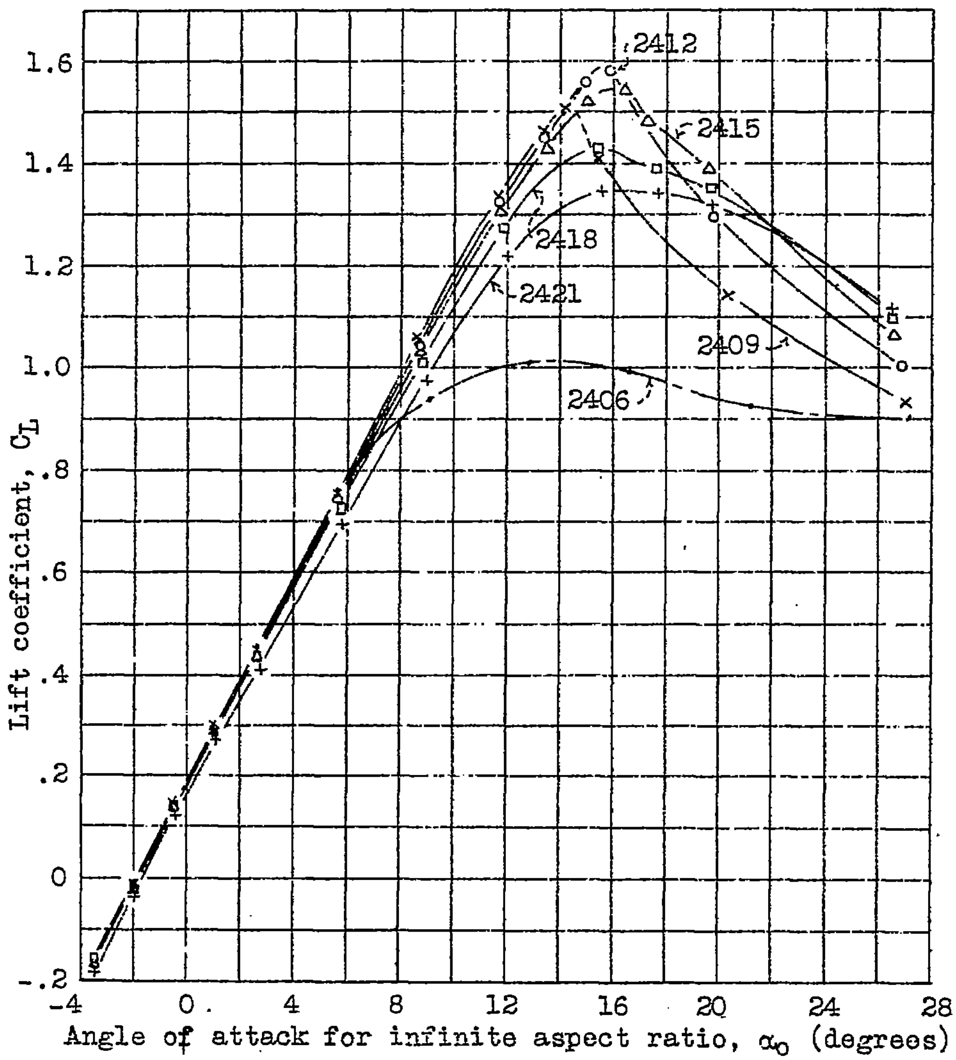


Fig. 3 Lift curves for N.A.C.A. 24 series airfoils.

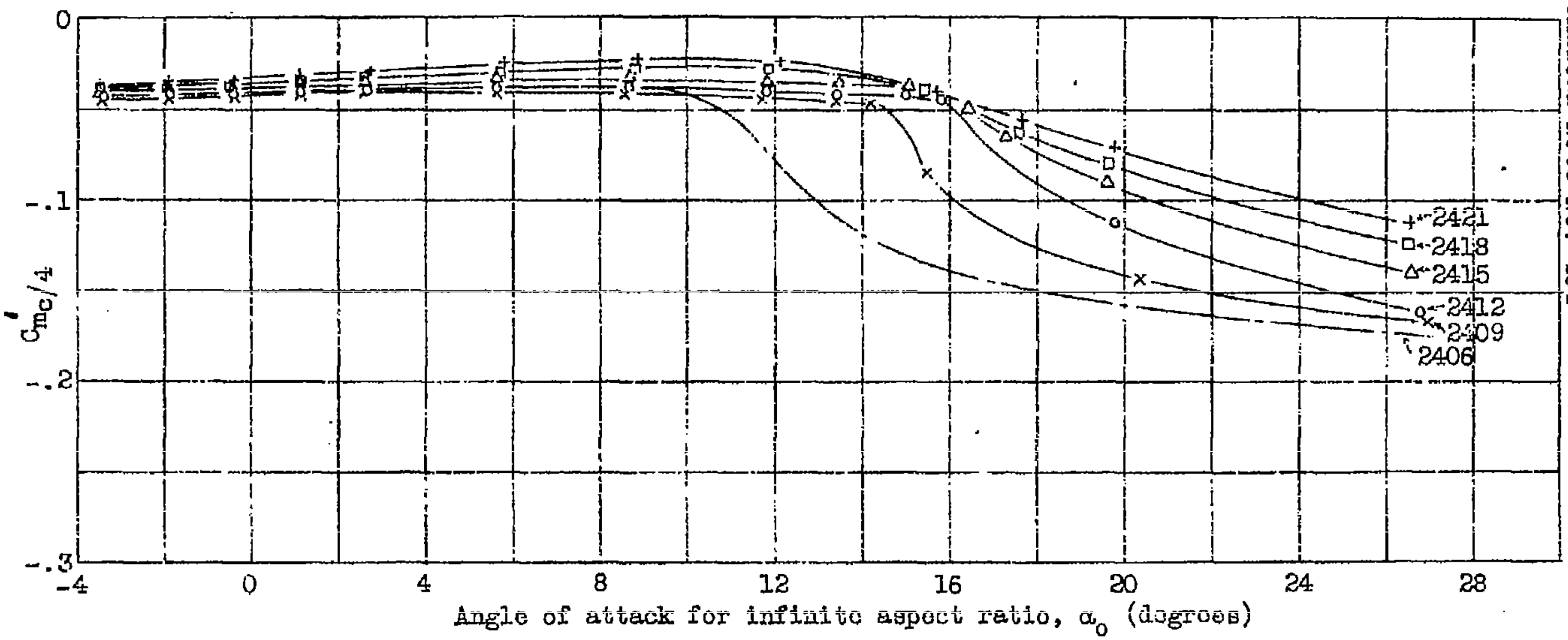
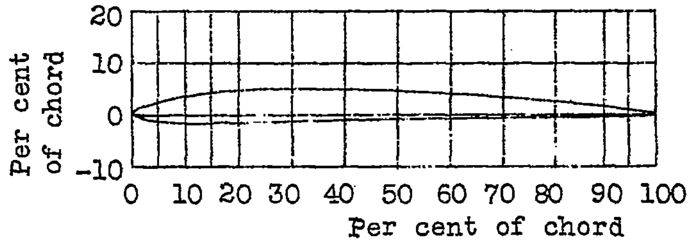
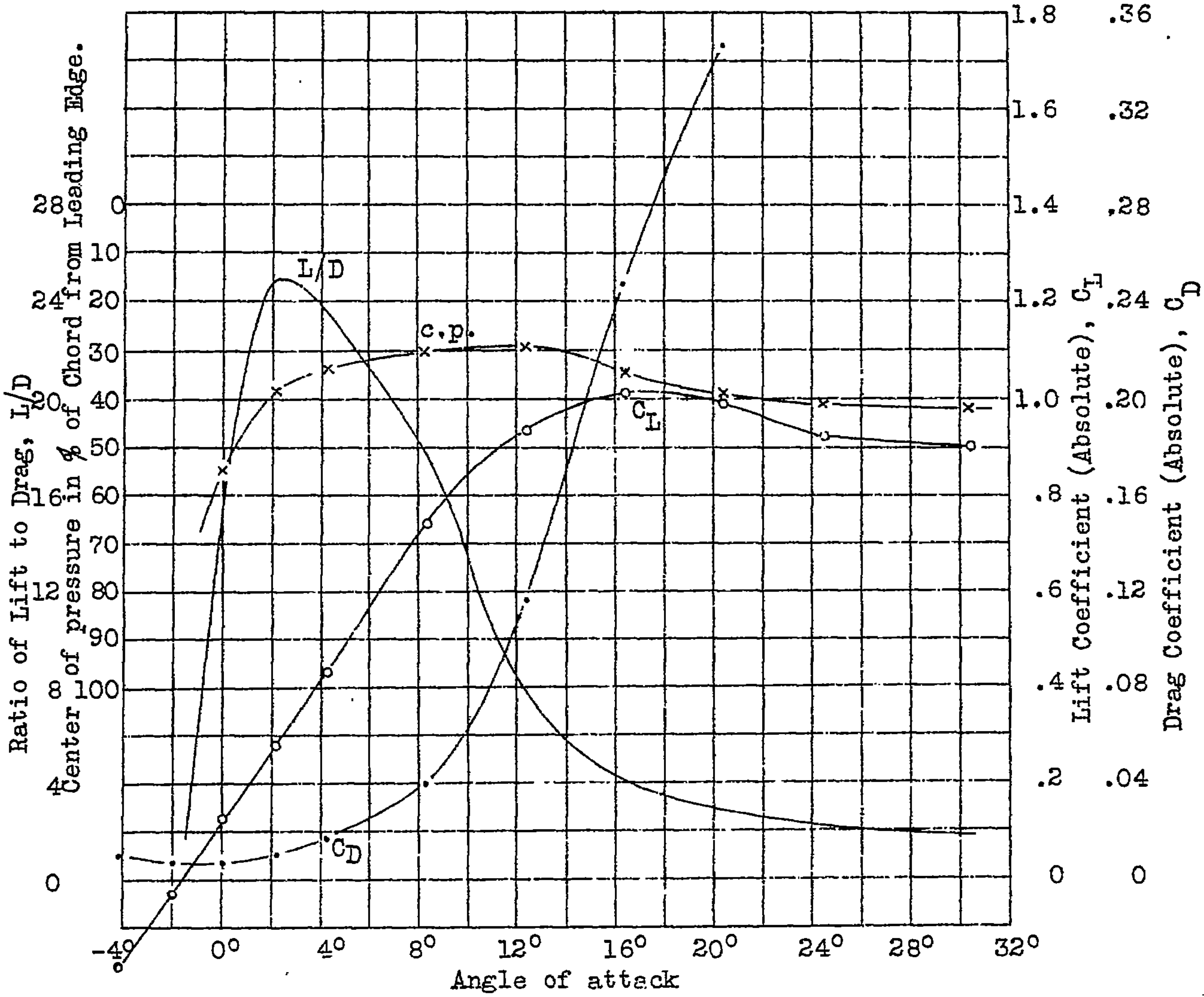


Fig. 4 Moment coefficients about a point one-quarter of the chord behind the leading edge.

%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R
0	0.00	0.00	20	4.37	-1.37	50	4.60	-0.70	90	1.35	-.11
1.25	1.11	-0.80	25	4.69	-1.25	60	4.08	-0.49	95	.73	-.08
2.50	1.57	-1.04	30	4.88	-1.12	70	3.35	-0.33	100	(.06)	(-.06)
5.00	2.28	-1.29	40	4.90	-0.90	80	2.44	-0.20	100	——	.00
7.50	2.81	-1.40									
10	3.24	-1.45									
15	3.90	-1.44									

L.E. Rad.: 0.394
Slope of radius through end of chord: 2/20





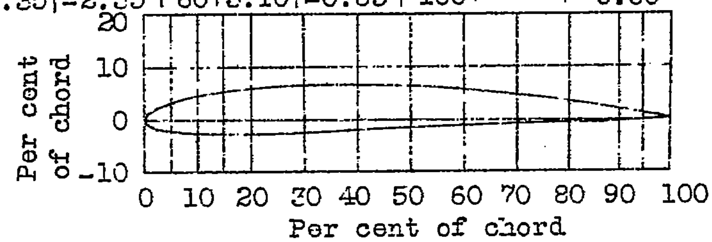
Name of section: N.A.C.A. 2406
Size of model: 5" x 30"
Pressure in standard atmospheres: 20.7
Wind velocity: 68.6 ft./sec.
Results corrected to aspect ratio 6 in free air.

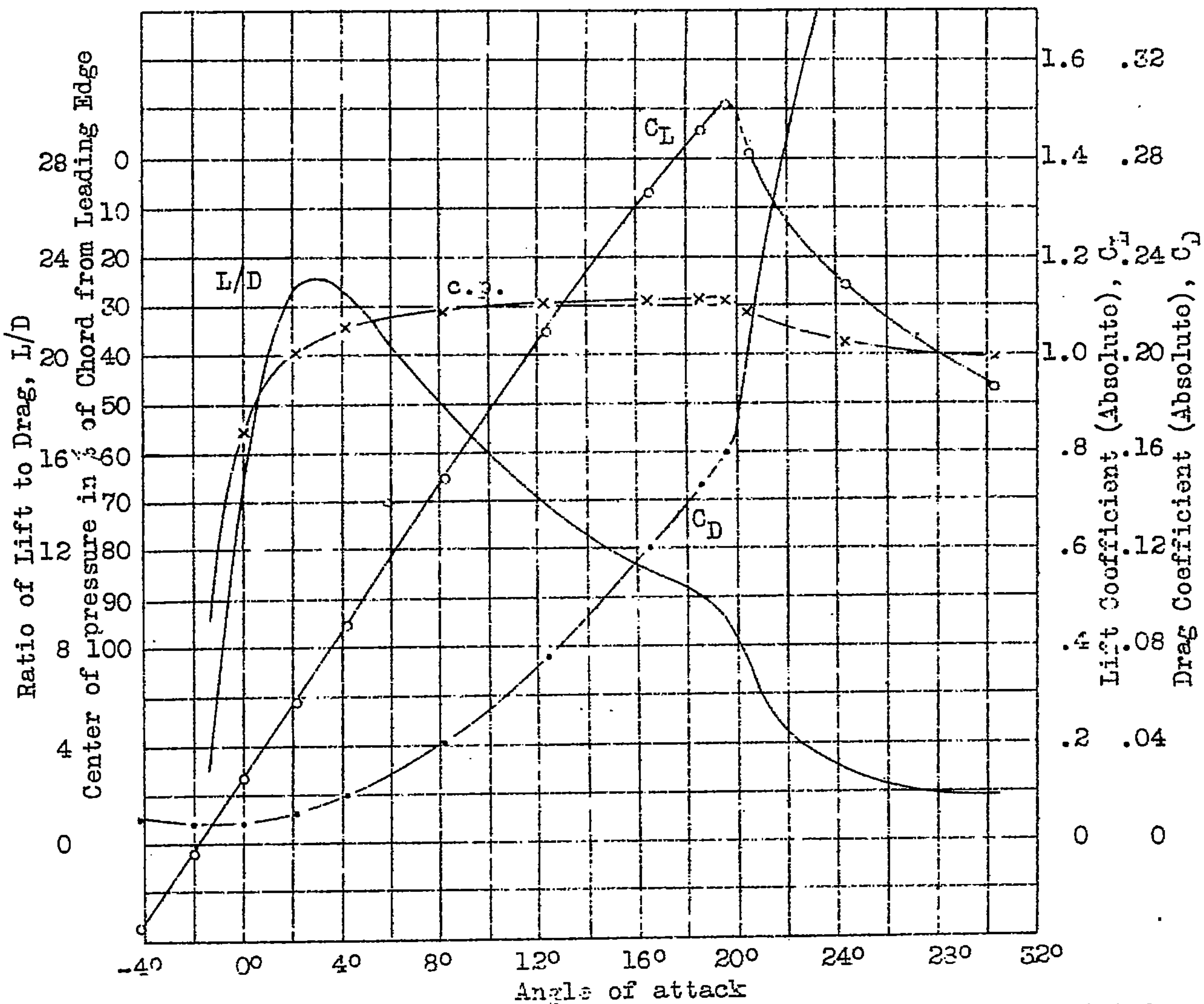
Reynolds No. 3,120,000
Test: V.D.T. 665
Date: Sept. 8, 1931

Fig. 5

%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R
0	0.00	0.00	20	5.81	-2.79	50	5.92	-2.02	90	1.72	-0.47
1.25	1.62	-1.23	25	6.18	-2.74	60	5.22	-1.63	95	0.94	-0.28
2.50	2.27	-1.66	30	6.38	-2.62	70	4.27	-1.24	100	(.10)	(-0.10)
5.00	3.20	-2.15	40	6.35	-2.35	80	3.10	-0.85	100	—	0.00
7.50	3.87	-2.44									
10	4.43	-2.60									
15	5.25	-2.77									

L.E. Rad.: 0.887
Slope of radius through end of chord: 2/20





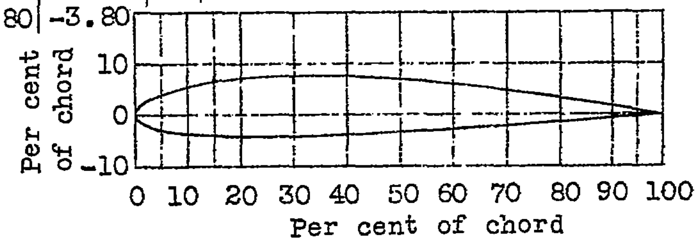
Name of section: N.A.C.A. 2409
Size of model: 5" x 30"
Pressure in standard atmospheres: 20.8
Wind velocity: 68.6 ft./sec.
Results corrected to aspect ratio 6 in free air.

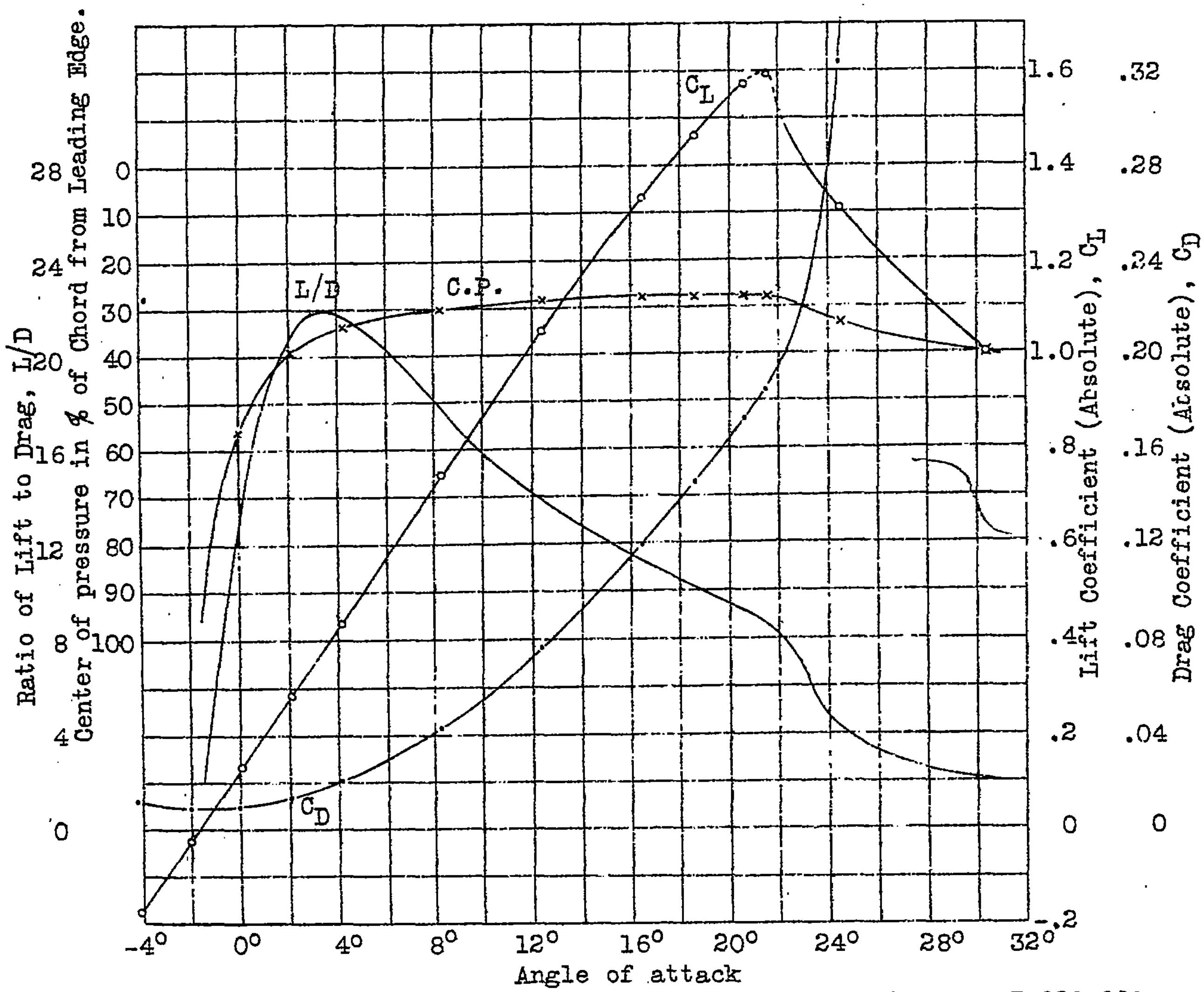
Reynolds No: 3,110,000
Test: V.D.T. 666
Date: Sept. 9, 1931

Fig. 6

%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R
0	0.00	0.00	15	6.61	-4.10	50	7.24	-3.34	90	2.08	-.82
1.25	2.15	-1.65	20	7.26	-4.23	60	6.36	-2.76	95	1.14	-.48
2.50	2.99	-2.27	25	7.67	-4.22	70	5.18	-2.14	100	(.13)	(-.13)
5.00	4.13	-3.01	30	7.88	-4.12	80	3.75	-1.50	100	—	.00
7.50	4.96	-3.46	40	7.80	-3.80						
10	5.63	-3.75									

L.E. Rad.: 1.576
Slope of radius through end of chord: 2/20.



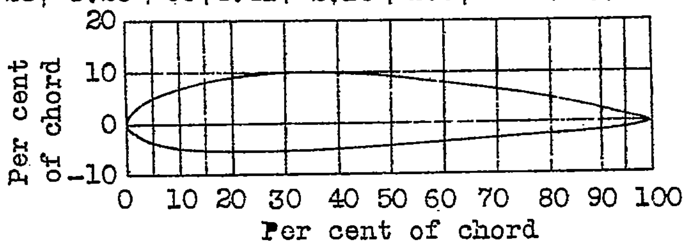


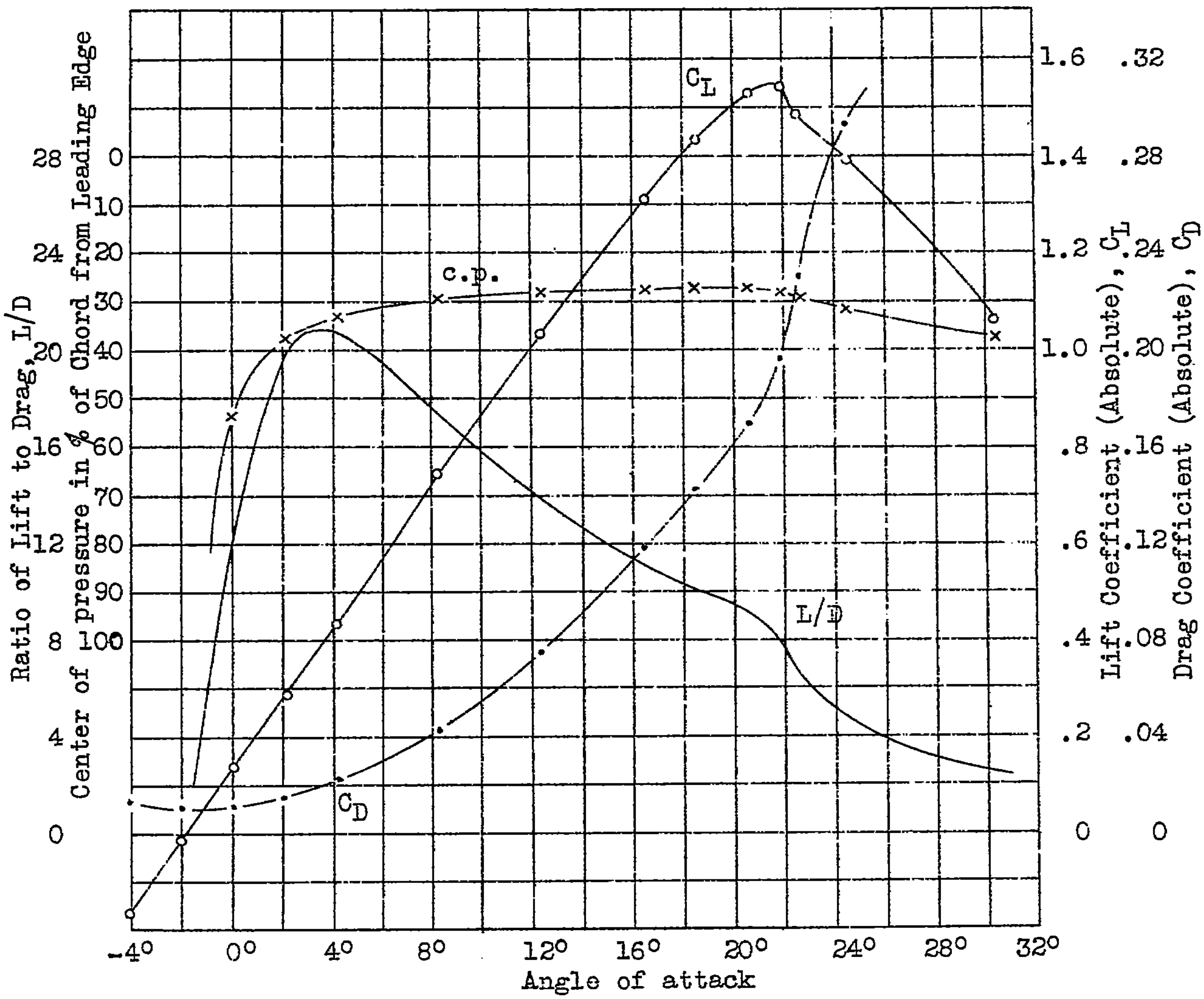
Name of section: N.A.C.A. 2412
Size of model: 5" x 30"
Pressure in standard atmospheres: 20.6
Wind velocity: 68.6 ft./sec.
Results corrected to aspect ratio 6 in free air.

Reynolds No. 3,020,000
Test: V.D.T. 667
Date: Sept. 9, 1931

%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R
0	0.00	0.00	20	8.70	-5.66	50	8.57	-4.67	90	2.45	-1.17
1.25	2.71	-2.06	25	9.17	-5.70	60	7.50	-3.90	95	1.34	-0.68
2.50	3.71	-2.86	30	9.38	-5.62	70	6.10	-3.05	100	(.16)	(-0.16)
5.00	5.07	-3.84	40	9.25	-5.25	80	4.41	-2.15	100	—	0.00
7.50	6.06	-4.47									
10	6.83	-4.90									
15	7.97	-5.42									

L.E. Rad.: 2.464
Slope of radius through end of chord: 2/20





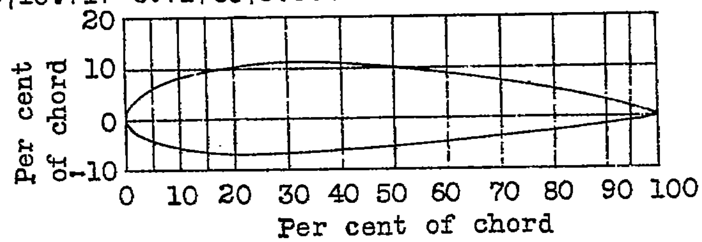
Name of section: N.A.C.A. 2415
Size of model: 5" x 30"
Pressure in standard atmospheres: 20.8
Wind velocity: 68.6 ft./sec.
Results corrected to aspect ratio 6 in free air.

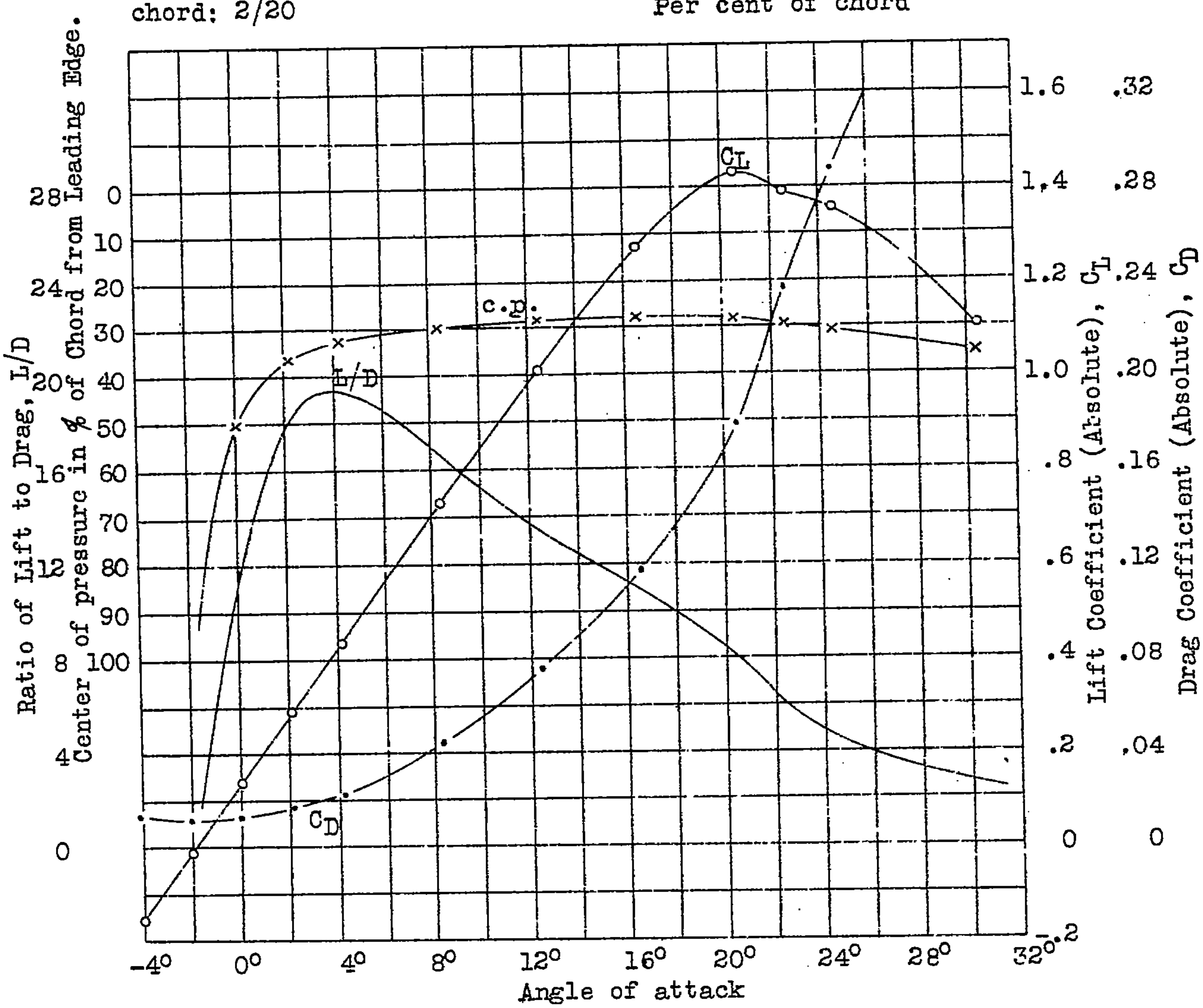
Reynolds No: 3,060,000
Test: V.D.T. 668
Date: Sept. 10, 1931

Fig. 8

%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R
0	0.00	0.00	20	10.15	-7.09	50	9.89	-5.99	90	2.81	-1.53
1.25	3.28	-2.45	25	10.65	-7.18	60	8.65	-5.04	95	1.55	-0.87
2.50	4.45	-3.44	30	10.88	-7.12	70	7.02	-3.97	100	(.19)	(-.19)
5.00	6.03	-4.68	40	10.71	-6.71	80	5.08	-2.80	100	——	.00
7.50	7.17	-5.48									
10	8.05	-6.03									
15	9.34	-6.74									

L.E. Rad.: 3.549
Slope of radius through end of chord: 2/20





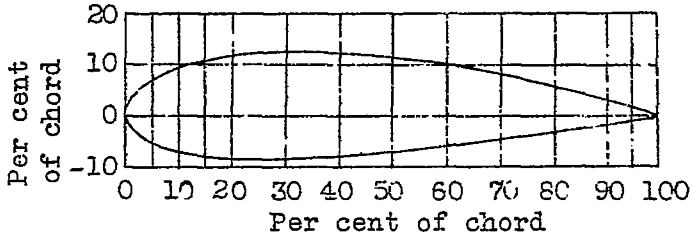
Name of section: N.A.C.A. 2418
Size of model: 5" x 30"
Pressure in standard atmospheres: 20.8
Wind velocity: 68.6 ft./sec.
Results corrected to aspect ratio 6 in free air.

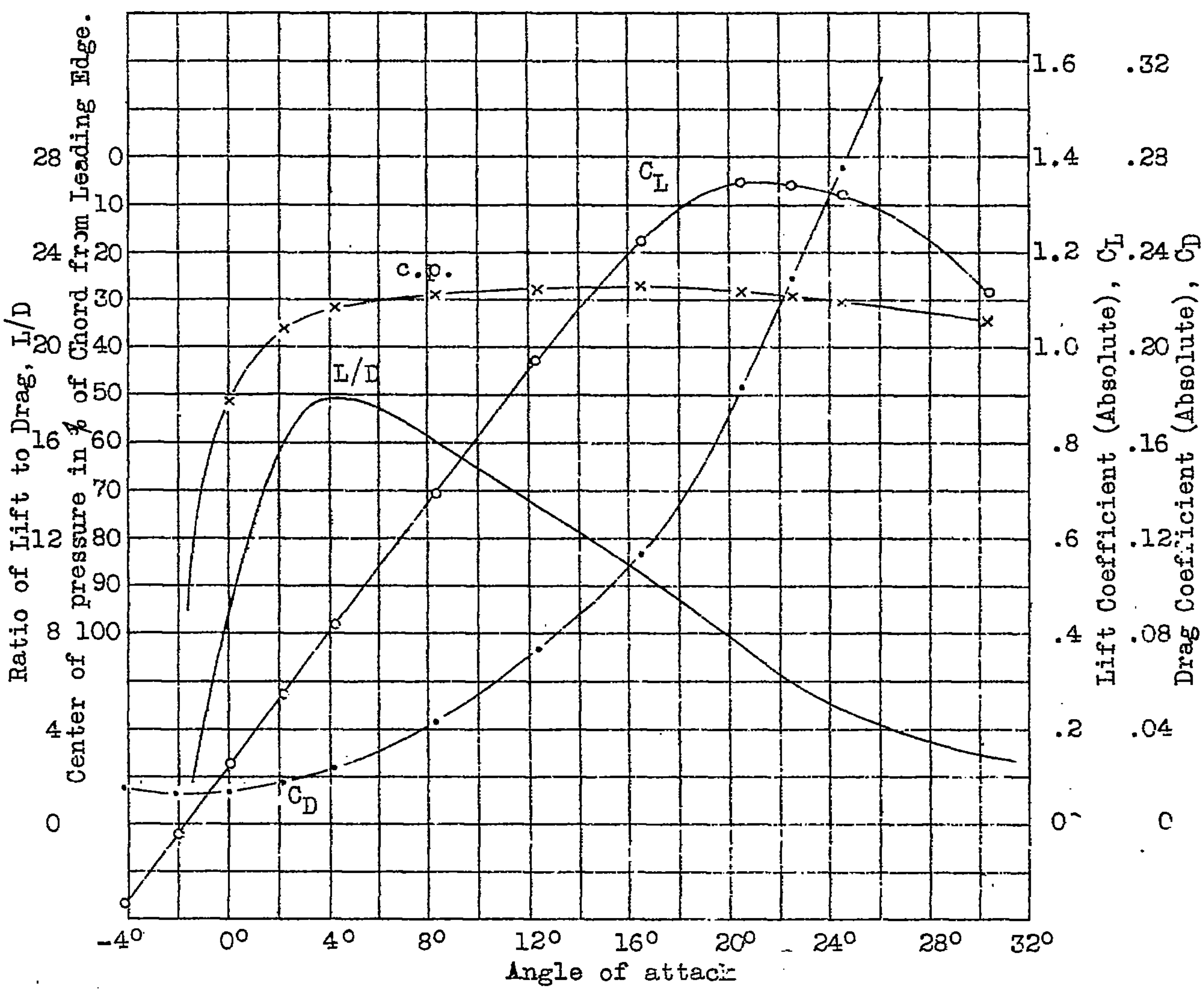
Reynolds No. 3,060,000
Test: V.D.T. 669
Date: Sept. 11, 1931

Fig. 9

%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R	%	UP'R	LW'R
0	0.00	0.00	20	11.59	-8.52	50	11.22	-7.31	90	3.18	-1.88
1.25	3.87	-2.82	25	12.15	-8.67	60	9.79	-6.17	95	1.76	-1.06
2.50	5.21	-4.02	30	12.38	-8.62	70	7.94	-4.87	100	(.22)	(-.22)
5.00	7.00	-5.51	40	12.16	-8.16	80	5.74	-3.44	100	——	0.00
7.50	8.29	-6.48									
10	9.28	-7.18									
15	10.70	-8.05									

L.E. Rad.: 4.830
Slope of radius through end of chord: 2/20





Name of section: N.A.C.A. 2421
Size of model: 5" x 30"
Pressure in standard atmospheres: 20.6
Wind velocity: 68.6 ft./sec.
Results corrected to aspect ratio 6 in free air.

Reynolds No. 3,000,000
Test: V.D.T. 670
Date: Sept. 11, 1931

Fig. 10

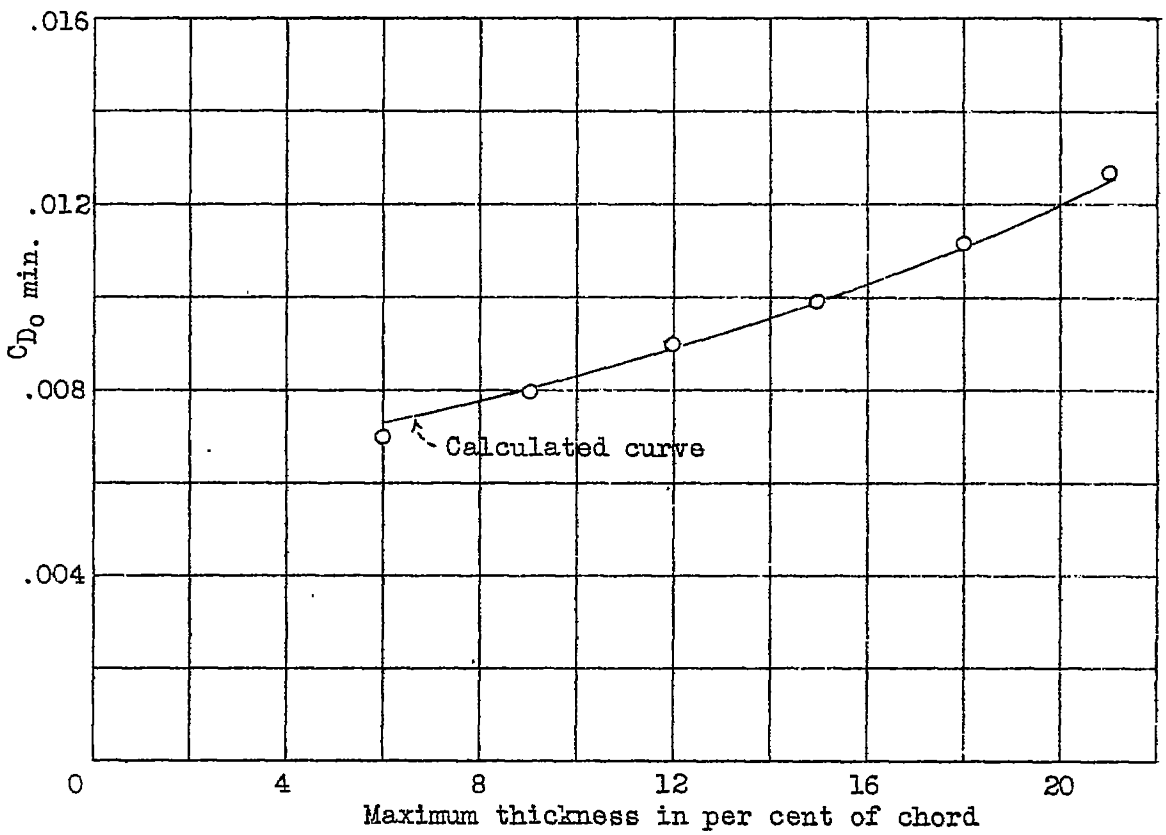


Fig. 11 Variation of minimum profile-drag coefficient with thickness

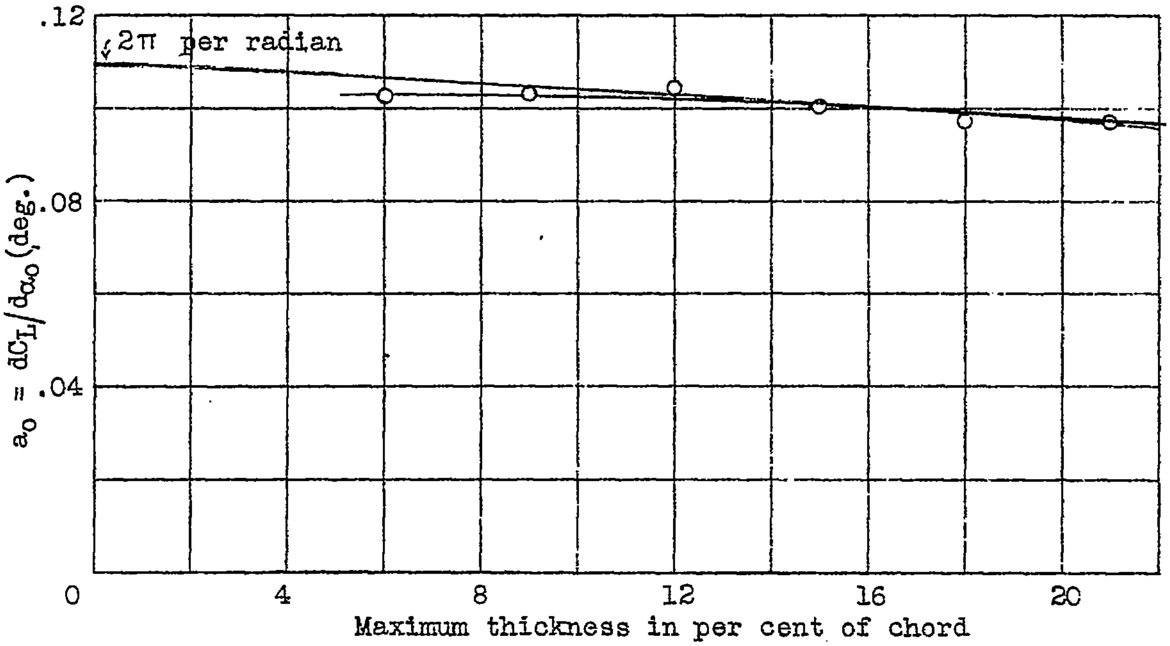


Fig. 12 Variation of lift curve slope with thickness.

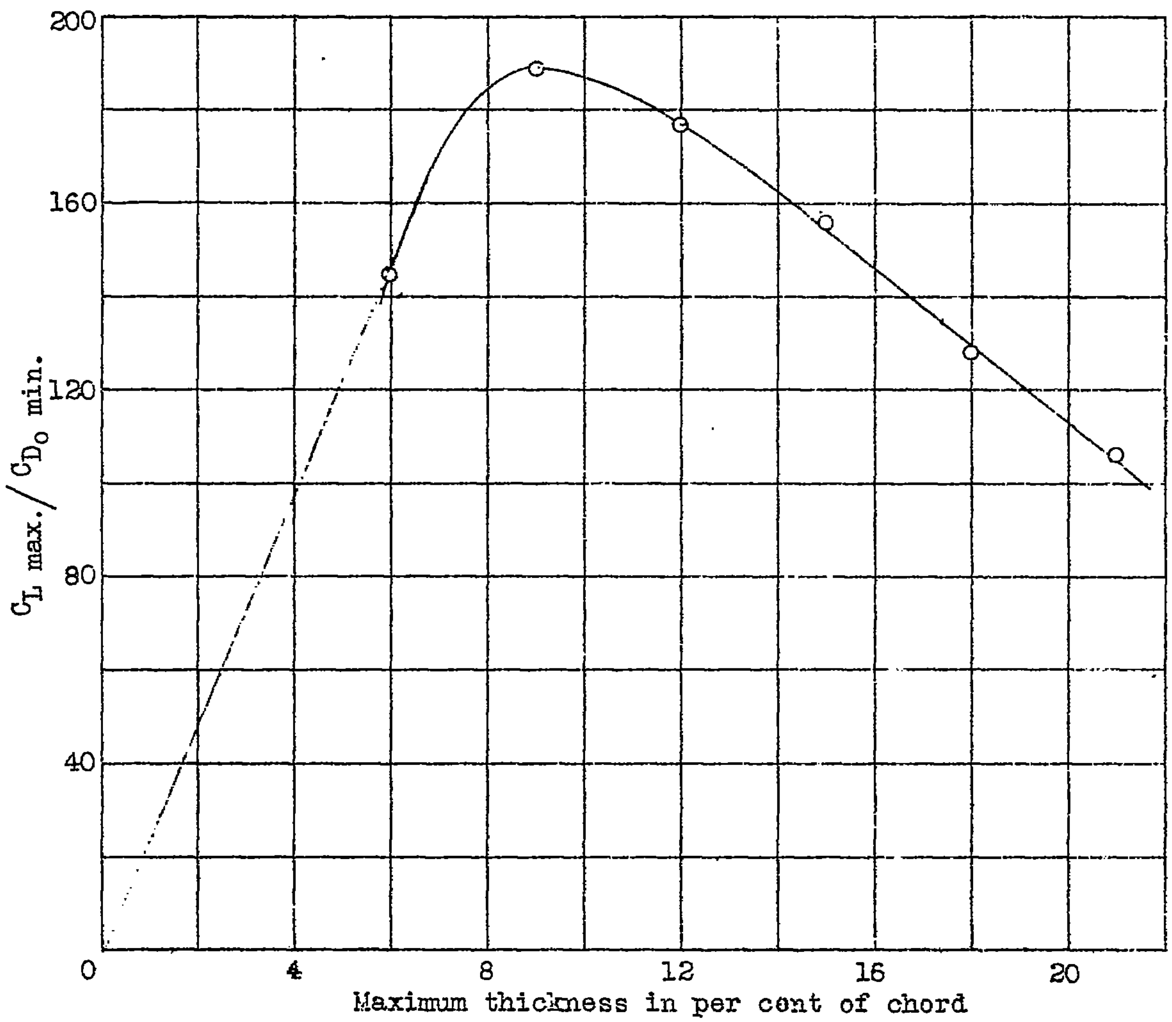


Fig. 13 Ratio of maximum lift to minimum profile drag.

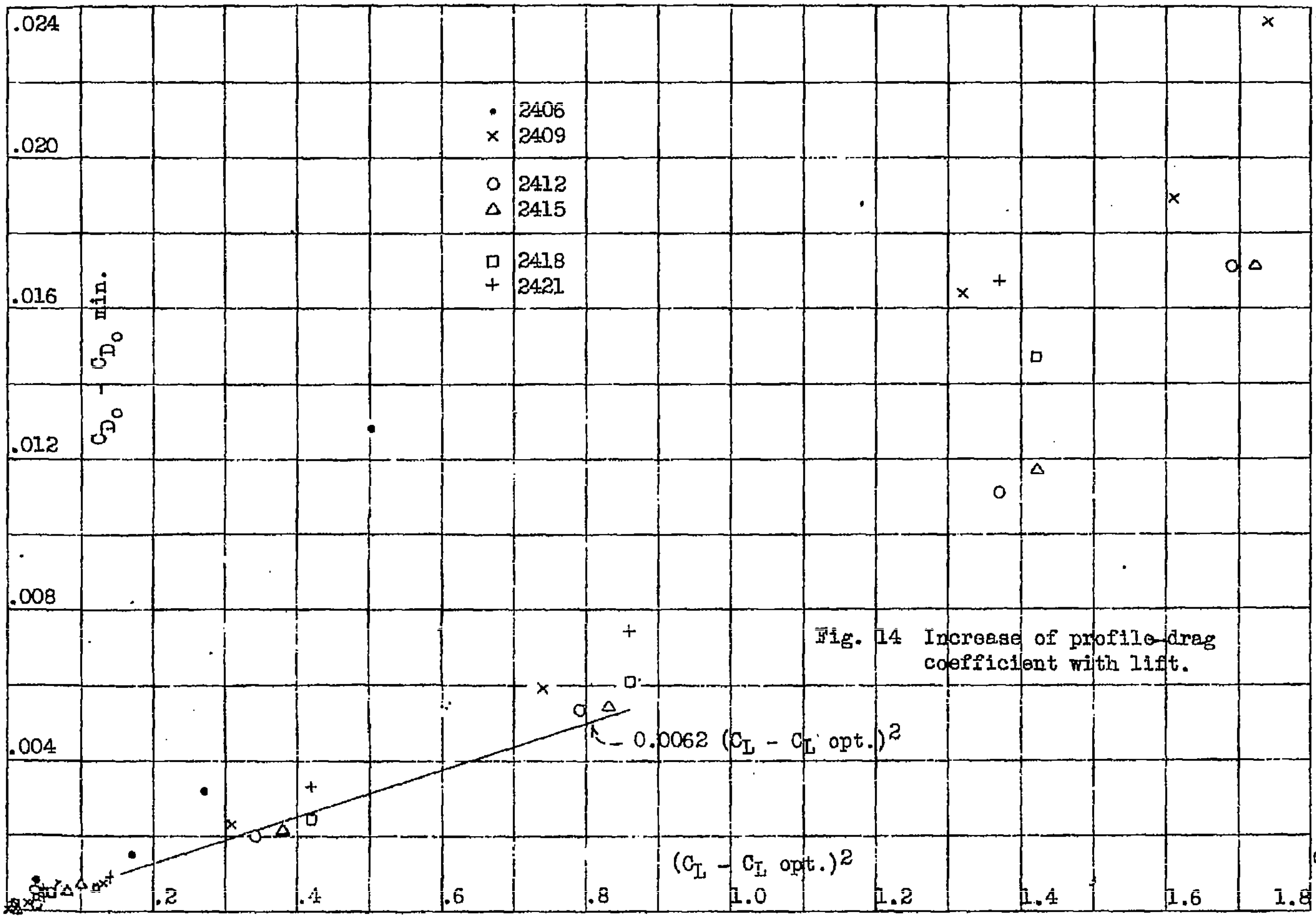


Fig. 14 Increase of profile-drag coefficient with lift.